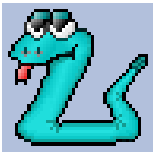
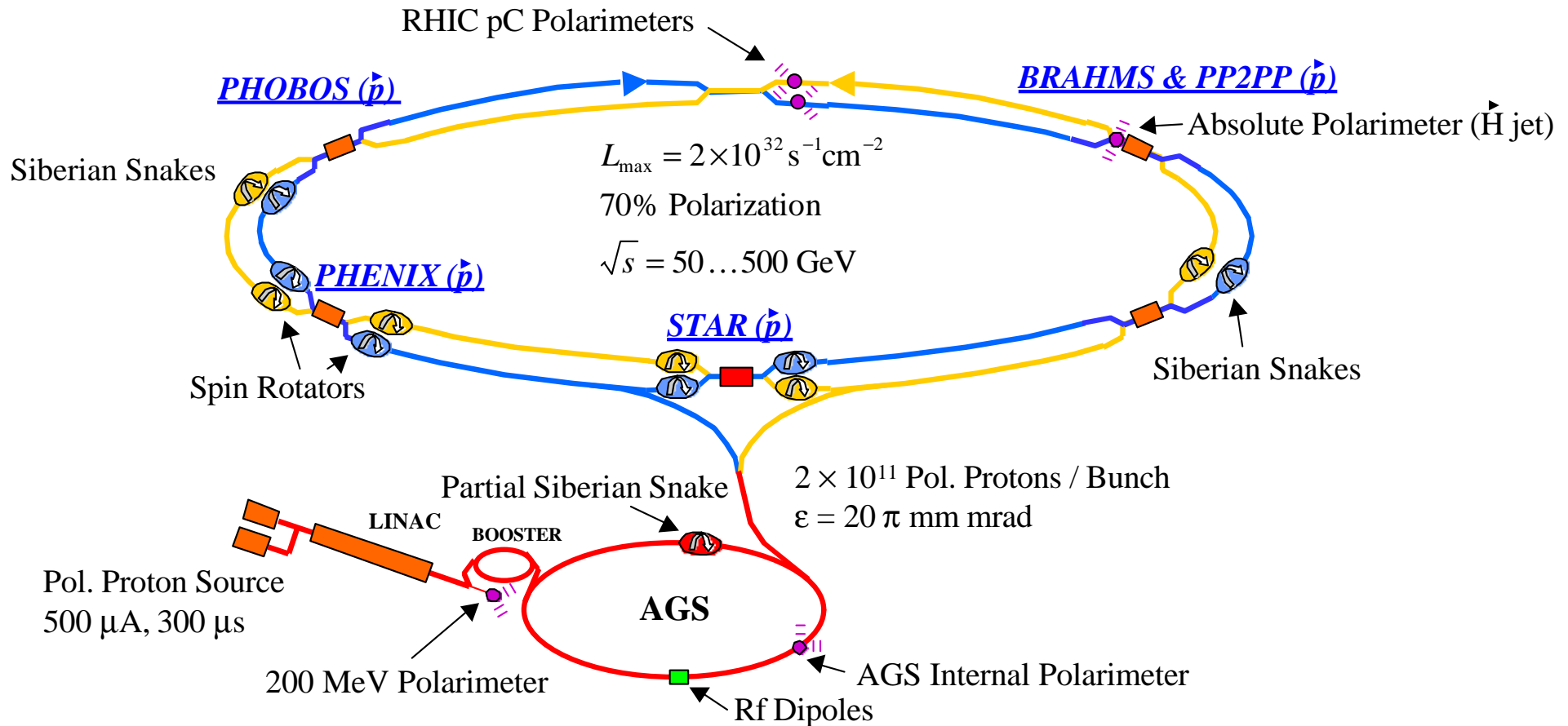


Machine Issues for RHIC Spin



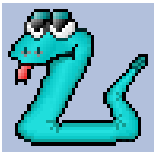
Goals

This run:

- ⌘ Trans. pol. protons colliding at ~ 100 GeV per beam ($P > 50\%$).
- ⌘ Long. pol. protons colliding at ~ 100 GeV per beam ($P > 50\%$).
- ⌘ Commission acceleration of pol. protons to 250 GeV per beam.

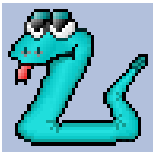
Next Run:

- ⌘ Long. Pol. at STAR and PHENIX with 250 GeV per beam.



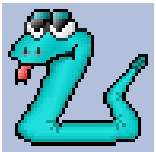
🐍 Schedule of Current Run 🐍

- 🐍 8 Nov: 1 shift shutdown to install AGS polarimeter.
- 🐍 9 → 26 Nov: Au in RHIC; pol protons in AGS.
- 🐍 26 → 29 Nov: Shutdown to change RHIC to pol. protons.
Run pol. protons in AGS.
- 🐍 30 Nov. → 21 Dec.: Commission pol. protons in RHIC.
- 🐍 22 Dec. → ~ 25 Jan.: Physics with pol. protons.



Commissioning Progress

- ⌘ Power supplies connected to all four snakes.
 - Not yet tested to full field.
 - Not yet tested with beam.
- ⌘ Polarized beam in AGS ($G\gamma = 7.5$ as of yesterday).
- ⌘ $\beta^* = 3$ m injection test scheduled for this afternoon.
 - Vertical flattening to surveyed positions yet to be done.
- ⌘ Spin flipper installed.
 - System previously tested outside ring.
 - Requires ring access when we first power it.

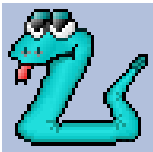


🎺 Status of Future Additions 🎺

- ~ 4 rotators completed and awaiting installation in RHIC.
- ~ 5th rotator cold mass being assembled.
- ~ 6th rotator all four helices cold tested.
- ~ 7th rotator: 4th helix being cold tested.
- ~ 8th rotator:
 - 3 of 4 helices stacked and in various stages of wiring the ends
 - last helix remains to be stacked and wired.
- ~ All helices to be finished by Dec., 2001.
- ~ Last rotator to be finished by April., 2002.
- ~ All 8 rotators to be installed in RHIC by Oct., 2002.

- New AGS Partial snake: Helical
 - requires more study: warm or supercond.
 - no definite plan yet.

- Polarized Jet Target: see following talks



Other links

AGS commissioning plan:

<http://www.rhichome.bnl.gov/People/huang/pp02/FY02plan.htm>

Previous talks:

<http://www.rhichome.bnl.gov/RHIC/Spin/spinfigs/figslist.html>

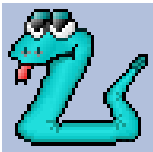
<http://www.rhichome.bnl.gov/RHIC/Spin/spinfigs/wwm-rsc1oct01.pdf>

Polarization angles at IR's and polarimeters for different energies:

<http://www.rhichome.bnl.gov/RHIC/Spin/spinfigs/100GeV-1snake.html>

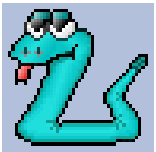
Other ideas for upgrades:

<http://www.rhichome.bnl.gov/RHIC/luminosity/>



Possible RHIC Upgrades

- Luminosity increase RHIC II: electron cooling
 - cool protons at injection (double luminosity over RDM+)
 - spin cooling with polarized electrons?
- eRHIC: polarized electrons and proton collisions
- Energy increase: (20–30%)



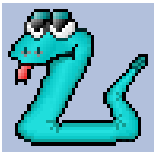
Parameters for Proton Collisions

Scheme		RDM	RDM+	RHIC II
Emittance (95%), ϵ	$[\pi\mu\text{m}]$	20	20	12*
IP beta function, β^*	$[\text{m}]$	2.0	1.0	1.0
Number of bunches, M		60	120	120
Bunch population, N	$[10^{11}]$	1.0	2.0	2.0
Beam-beam parameter per IR, ξ		.0037	.0073 [†]	.012 [‡]
Angular beam size, σ'^*	$[\mu\text{rad}]$	79	112	86
RMS beam size, σ^*	$[\mu\text{m}]$	158	112	86
Peak Luminosity, L_0	$[10^{31}\text{cm}^{-2}\text{s}^{-1}]$	1.5	24	40

* For RHIC II assumes electron cooling at injection to reduce emittance.

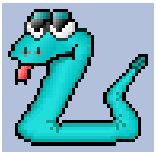
[†] For RDM+ assumes only collisions at 3 IR's.

[‡] For RHIC II assumes only collisions at 2 IR's.

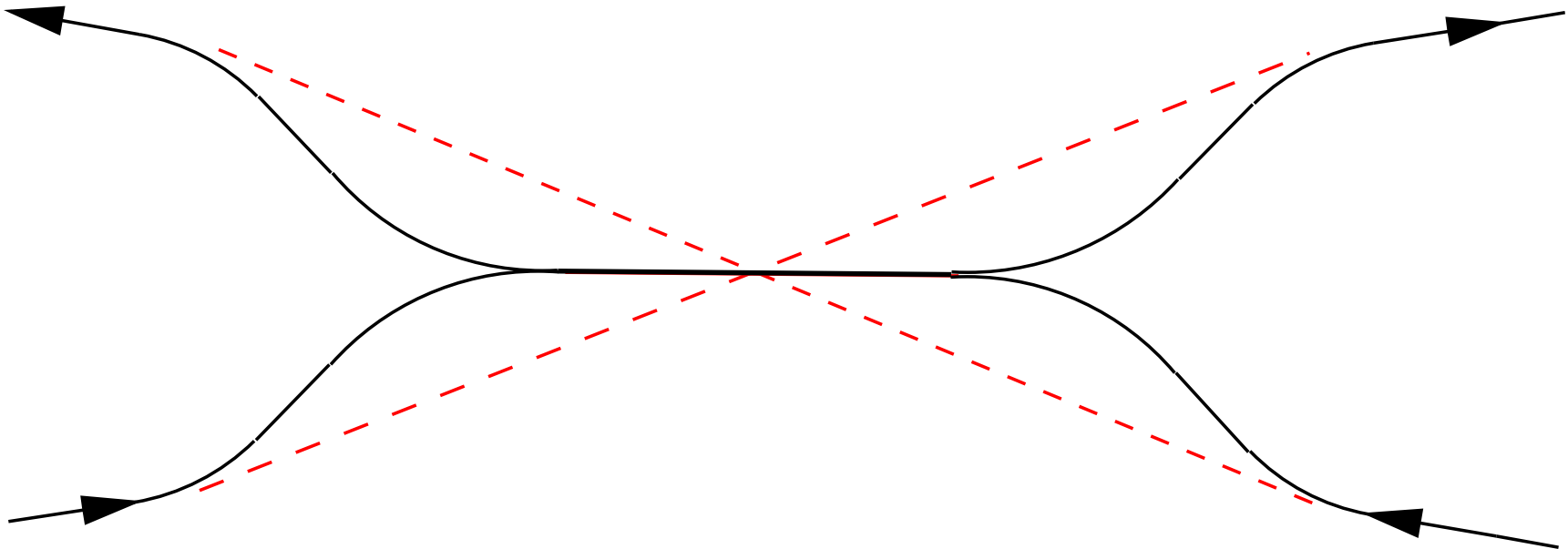


Increasing Energy

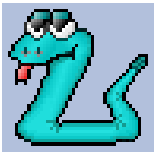
We have considered the possibility of increasing the energy of beams in RHIC by as much as 30% with a modest trade-off in luminosity. The arc dipoles and quadrupoles were designed with considerable margin. For higher energies (> 100 GeV/nucleon) the minimum β^* may be required to increase as the interaction region triplets saturate. The separator magnets (DX) have the least margin for increased field, so we consider three scenarios: allowing for a small crossing angle with the present DX magnets, upgrading the DX magnets to higher strength, and permitting a crossing angle of $\sim 1^\circ$ by removing the DX magnets altogether.




Trajectories of Both Beams Through IR



The **dashed** lines indicate trajectories without DX magnets.
The crossing angle without DX's is $\alpha = 0.18 \text{ mrad}$.




Conclusions for an energy upgrade

 25 → 30% increase in energy looks possible.

 0° crossing angle requires new D0 & DX magnets.

 Higher energies require all new dipoles.


 2.5 mrad crossing angle perhaps possible with existing magnets.

 DX magnets may only make 10–15% more energy.

 **18 mrad crossing angle**

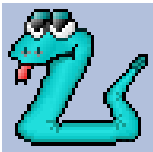
 DX magnet not needed.

 D0 magnet runs at low field ($B \sim 1.6$ T).

 Snakes work in all scenarios.

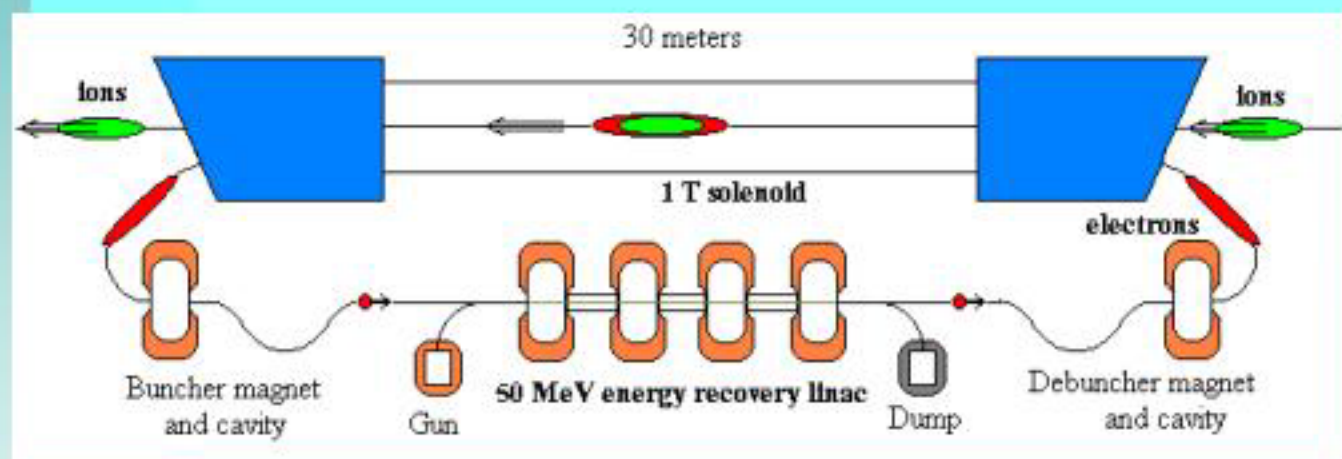
 Spin rotators should work.

 For 18 mrad crossing angle: reverse power supplies.



Schematic of the RHIC Cooler

- Energy Recovery Linac
- Buncher - debuncher

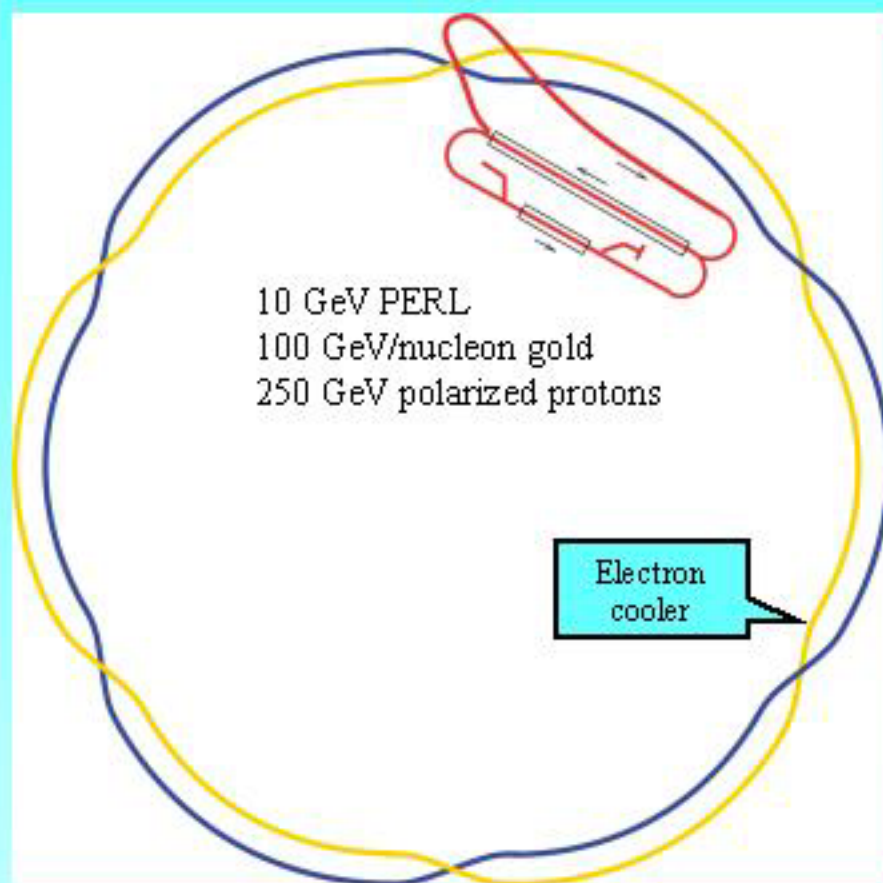


> x10 increase in the integrated luminosity of RHIC,
as well as better accumulation of rare species.

Ilan Ben-Zvi

Beam Cooling and Related Topics
Bad Honnef, May 14-18, 2001

eRHIC – a Polarized Electron on Ion or Polarized Proton in RHIC



The Electron-Ion Collider is proposed as an essential tool for research into the fundamental structure of matter:

- What is the *structure* of hadrons in terms of their quark and gluon constituents?
- How do quarks and gluons *evolve* into hadrons via the dynamics of confinement?
- How do the quarks and gluons *reveal* themselves in the structure of atomic nuclei?

Ilan Ben-Zvi

Beam Cooling and Related Topics
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